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Processing coconut oil

The high content of medium-chain fatty acids in coconut oil makes it a unique 'fat-burning' functional oil, according to S. P. Kochhar, who looks at how processing can give coconut oil a longer shelf-life and better health aspects

Coconut oil is derived from copra, which is the dried kernel or 'meat' of coconut. Coconuts are fruit of the coconut palm (*Cocos nucifera L*), which is cultivated in tropical coastal areas. The usual tall variety of coconut tree reaches a height of over 30m. Typically, fresh coconut kernel contains (by % of weight), moisture (50%), oil (34%), carbohydrate (7.3%), protein (3.5%), fibre (3.0%) and ash (2.2%) (*Canapi et al 2005*).

World production of coconut oil (CNO) or copra oil is about 3.4M tonnes, about half of which is traded internationally. The main producing countries are India, Indonesia, Papua New Guinea, the Philippines, Solomon Islands, Sri Lanka, Thailand and West Malaysia. The Philippines and Indonesia are major exporters, while the EU countries and USA are major importers. CNO is a lauric oil (about 50% lauric acid) similar in composition to palm kernel and babassu oils. In addition to triacylglycerols and free fatty acids, crude CNO also contains 0.5-1.5% unsaponifiable matter (*Codex, 2009*). This material consists mainly of sterols, tocopherols, squalene, pigments and odour compounds (such as lactones). The pleasant odour and taste of CNO when extracted from fresh material is mainly due to γ- and δ-lactones, present in trace amounts. γ-Valerolactone is considered to be responsible for the characteristic taste of coconut oil.

TABLE 1: QUALITY CRITERIA LIMITS FOR REFINED COCONUT OIL (CNO) AND VIRGIN COCONUT OIL (VCNO)

Parameter	CNO	VCNO
Moisture (% weight)	0.1 max	0.2 max
Refractive index (40°C)	1.448-1.450	1.448-1.449
Insoluble material (% weight)	0.05	0.05
Unsaponifiable matter (% weight)	≤ 0.15	0.2-0.5
Acid value (% lauric acid)	0.1 max	0.2 max
Peroxide value (meq 02 /kg)	1.0 max	1.5 max
Induction period (hrs) at 100°C	123-132	200-232
Trans fatty acids (% weight)	0.5 max	0-0.1 max
Trace metals (mg/kg)		
Copper (Cu)	0.1 max	0.4 max
Iron (Fe)	1.5 max	5.0 max

Note: Induction period indicates oxidative stability of the oil, which provides the likely oil shelf life

SOURCE: IBRAHIM (2011); KOCHHAR (2016); APCC (ASIAN AND PACIFIC COCONUT COMMUNITY STANDARDS FOR VCNO)

Production and processing

Coconut oil is generally classified into two categories: virgin coconut oil and refined, bleached and deodorised (RBD) coconut oil. Both types are referred to as pure coconut oil, and the main difference is in the production and refining process.

REFINED COCONUT OIL

The first step in CNO production is dehulling, which involves cracking the shell to take out the meat or kernel. The kernel contains about 50% moisture, and it is dried to a moisture content of 6-8% before oil extraction. This can be achieved by drying the kernel under the sun, with direct heat or through the use of hot air. The dried kernel, known as copra, has an oil content of about 64%. Usually, the oil is extracted from the copra by pressing in screw presses (expellers), followed by solvent extraction to recover the residual oil from the cake.

The crude CNO is then refined by traditional chemical or physical refining steps to remove impurities. making it suitable for human consumption and better prolonged shelf life. In traditional physical refining, the crude oil is first treated with 0.05-0.1% aqueous phosphoric acid or a mixture of citric and phosphoric acid (plus a small amount of natural antioxidant, namely Y-tocopherol 50mg/kg, as a processing aid to enhance shelf life) to remove phospholipids and heated to 80-90°C for 20-30 minutes. The pre-treated oil is then bleached with a mixture of bleaching earth and activated carbon (10:1 ratio) at 90-95°C for 20-30 minutes and finally de-acidified/steam deodorised at 220-240°C under vacuum for about one hour. Due to the removal of desirable odour components in the last stage of refining, the RBD coconut oil possess little or no 'typical' pleasant coconut odour and taste.

VIRGIN COCONUT OIL

Virgin coconut oil (VCNO) is extracted from fresh coconut milk obtained from the mature kernel of a coconut by mechanical means with or without heat application. Generally, the following steps are used to produce quality grade VCNO:

- De-husking of coconuts; de-shelling; removal of brown testa; blanching; draining; grinding; grinded 'meat'; press; coconut milk; centrifugation; separators (2 or 3); oil (28-30°C); heat exchanger; vacuum drying; and filter.

Coconut milk is a natural oil-in-water emulsion. The oil separated by centrifugation is filtered to remove any solids present. The residue, flake/defatted desiccated coconut is dried and is often used as flour. Virgin coconut oil processed without any refining or deodorisation is colourless and has natural fresh coconut aroma and taste. VCNO is gaining popularity worldwide; the oxidative stability (shelf life) as well as health benefits of virgin coconut oil is better than that of RBD coconut oil – mainly due to its comparatively higher contents of tocopherols, polyphenols and other bio-active compounds.

Since VCNO and CNO come from the same source (coconut kernel or 'meat'), differing only in the way they are processed, the major characteristics of the two oils are very similar. Quality criteria limits for RBD coconut oil and virgin coconut oil are presented in Table 1 (*above*).

Some physical characteristics, typical fatty acid composition and Codex ranges of coconut oil are shown in Table 2 (*right*). It can be seen that CNO contains about 92% saturated fatty acids; this makes the crude oil very stable against oxidation. However, RBD oil has less oxidative stability compared to the crude oil due to some losses in natural antioxidants (tocopherols) during the refining process. The crude oil also contains, apart from unsaponifiable components, small amounts of protein, crude fibre and trace metals such as iron, lead and copper.

Most of these undesirable materials are removed during the refining, bleaching and deodorisation process. By applying modern technologies and refining under optimal conditions, the losses in contents of desirable minor components such sterols and tocopherols are minimised to 10 to 15% of their respective original amounts present in crude oil.

The shelf life (oxidative stability) of the refined oil can be improved considerably by dosing with citric acid solution (as a chelating agent of any residual pro-oxidant trace metals) during the cooling stage of deodorisation.

Sterols composition (% of total) and Codex ranges of coconut oil are presented in Table 3 (*right*). It can be seen that total sterols amount to about 800 mg/kg of oil and the major ones present are β-sitosterol (about 47%) and Δ^5-avenasterol (about 27%). On comparison with palm kernel oil, coconut oil contains less β-sitosterol and more Δ^5-avenasterol. The ratio of β-sitosterol to Δ^5-avenasterol is about 1.8 in coconut oil and about 11.6 in palm kernel oil. The determination of this ratio will add extra support to assess any adulteration of palm kernel oil into pure refined coconut oil or virgin coconut oil, which is analysed by fatty acid composition data alone.

The total tocopherols content of coconut oil vary from trace to 50 mg/kg, and Codex ranges of individual tocopherols content (mg/kg) are reported: α-tocopherol (nd-17), β-tocopherol (nd-11), Y-tocopherol (nd-14), α-tocotrienol (nd-44) and Y-tocotrienol (nd-1; nd = not detected).

Fatty acids with 8 to 12 carbon atoms are classified as medium-chain fatty acids (MCFAs). The sum of MCFAs in coconut oil is about 62%, which makes the oil the richest source of MCFAs among vegetable oils. In spite of being highly saturated, the oil has a relatively low melting point since it contains mainly short- and medium-chain fatty acids. Therefore, coconut oil can be used without any modification in a vast variety of food products.

Uses in food and oleochemicals

Coconut oil, which has a high quality image, is used for a vast variety of food products but its non-food, oleochemical use is also very large. Coconut oil is commonly used as a frying medium (mainly shallow frying for domestic purpose, but also on small scale deep-frying e.g. frying banana chips in South India) in tropical countries, especially in the Philippines and India. However, it is not suitable for industrial frying due to the liberation of quite volatile medium-chain fatty acids, which causes excessive smoke development.

Coconut oil is very popular for use in personal care products. It is interesting to note that the products (medium-chain triglycerides [MCTs]) made from glycerol and coconut fatty acids (caprylic C8:0 and capric C10:0) are easily absorbed in the digestive tract (*List, 2016*). Therefore, MCTs are used as an immediate energy source in the body, avoiding being stored in adipose tissue and are thus useful ingredients in sports foods, infant foods and in clinical nutrition applications. There are also many commercial products that use lauric acid and monolaurin as antimicrobial agents.

Health aspects

Coconut oil is high in lauric acid (45-50%) and a rich source of MCTs. Many of the health claims of CN0 correspond to these unique property contents. Studies conducted on people living on Pacific Islands, where coconut oil constituted 30-60% of calories, have shown nearly non-existent rates of cardiovascular disease, and the inhabitants are healthy and trim.

Several positive health benefits of coconut oil are reported to include heart health, promotion of weight loss, better immune system health, healthy

TABLE 2: SOME CHARACTERISTICS, FATTY ACID COMPOSITION AND CODEX RANGES OF CNO

Parameter	Mean	Range	Codex 2009
Iodine value	8.5	6.3-10.8	6.3-10.6
Slip melting point (°C)	24.1	23.0-25.0	-
Fatty acid (% weight)			
C6:0	0.4	0-0.6	nd-0.7
C8:0	7.3	4.6-9.4	4.6-10.0
C10:0	6.6	5.5-7.8	5.0-8.0
C12:0	47.8	45.1-50.3	45.1-53.2
C14:0	18.1	16.8-20.6	16.8-21.0
C16:0	8.9	7.7-10.6	7.5-10.2
C18:0	2.7	2.5-3.5	2.0-4.0
C18:1	6.4	5.4-8.1	5.0-10.0
C18:2	1.6	1.0-2.1	1.0-2.5
C18:3	-	-	nd-0.2
C20:0	0.1	0-0.2	nd-0.2

TABLE 3: STEROLS COMPOSITION (% OF TOTAL) AND CODEX RANGES OF CNO

Parameter	Mean	Range	Codex
Cholesterol	1.7	0.6-3.0	nd-3.0
Brassicasterol	0.5	nd-0.09	nd-0.3
Campesterol	8.7	7.5-10.2	6.0-11.2
Stigmasterol	12.5	11.4-13.7	11.4-15.6
β-Sitosterol	46.7	42.0-52.7	32.6-50.7
Δ^5-Avenasterol	26.6	20.4-35.7	20.0-40.7
Δ^7-Stigmastenol	2.4	nd-3.0	nd-3.0
Δ^7-Avenasterol	1.1	0.6-3.0	nd-3.0
Others	1.1	nd-3.6	nd-3.6
Total (mg/kg)	807	470-1,110	400-1,200

SOURCE: IBRAHIM (2011); CODEX ALIMENTARIUS (2009). KEY: ND = NOT DETECTED

skin and thyroid function. Recently, Dayrit (2015) has reviewed in depth the mechanistic support for various beneficial effects of coconut oil. The positive supplementation effects of consuming VCNO on quality of life among breast cancer patients have been reported (*Law et al, 2014*). From animal studies, it has been reported that CNO supplementation reduces the blood pressure and oxidative stress in spontaneously hypertensive rats (*Bendeira-Alves et al, 2014*).

In the body, the lauric acid containing MCTs are converted into monolaurin, which reportedly has antiviral, antibacterial, and antiprotoza properties. It is claimed this monoglyceride is capable of destroying lipid-coated viruses such as HIV, herpes, measles, pathogenic bacteria, and giardia lamblila protozoa (*List, 2016*).

Moreover, lauric acid has also been reported to have a more favourable effect on lowering HDL cholesterol ratio than other higher chain saturated fatty acids (*Mensink et al, 2003*). Coconut oil containing about two-thirds medium-chain fatty acids can permeate cell membranes easily. In other words, they are easily digested and sent directly to the liver where they are converted to energy rather than stored as fat. This is why CNO is sometimes reported as being a 'fat-burning' health beneficial oil, which should be taken as a part of balanced diet and active lifestyle. ●

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For references, please go to www.ofimagazine.com/processingcoconutoil